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Mental health of dogs formerly used as 'breeding stock' in commercial breeding establishments

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ABSTRACT

Canine commercial breeding establishments (CBEs) are kennel facilities where puppies are produced in large numbers for commercial sale. In the popular media, CBEs are commonly referred to as "puppy mills" or "puppy farms." Conditions in CBEs vary widely in quality. Dogs in these facilities are routinely housed for their entire reproductive lives in cages or runs, and provided with minimal to no positive human interaction or other forms of environmental enrichment. Numerous anecdotal reports have suggested that after removal from CBEs many of the former breeding dogs display persistent behavioural and psychological abnormalities when compared with the general pet dog population. The purpose of this study was to determine if this anecdotal evidence could be confirmed empirically.

Behavioural evaluations of the dogs were obtained from current owners/fosterers using the Canine Behavioural Assessment and Research Questionnaire (C-BARQ), which utilizes ordinal scales to rate either the intensity or frequency of the dog's behaviours. A total of 1169 former CBE dogs were included in the study.

Among the CBE ex-breeding dogs, 76 different breeds were represented. With the exception of the Bichon Frise (31.5%), all other breeds comprised <5% of the dogs. The sex ratio was 70.3% females and 29.7% males. The dogs had been living in their adoptive homes for an average of 2 years when the C-BARQ was completed.

When compared with a convenience sample of pet dogs matched for breed, sex, age and neuter status, former CBE breeding dogs were reported as showing significantly higher rates of health problems (23.5% versus 16.6%, $P=0.026$). With respect to behaviour, CBE dogs displayed significantly higher rates of fear (both social and nonsocial; ordinal GLM models, $P<0.001$), house-soiling ($P<0.001$), and compulsive staring ($P<0.005$); and significantly lower rates of aggression (toward strangers and other dogs; $P<0.0001$), trainability ($P<0.0001$), chasing small animals ($P<0.0001$), excitability ($P<0.0001$), and energy ($P<0.0001$).

By demonstrating that dogs maintained in these environments develop extreme and persistent fears and phobias, possible learning deficits as evidenced by lower trainability, and often show difficulty in coping successfully with normal existence, this study provides the first quantitative evidence that the conditions prevailing in CBEs are injurious to the mental health and welfare of dogs.

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1. Introduction

The commercial dog breeding industry is a major producer of purebred dogs in many countries around the world. The owners of these facilities refer to themselves

by different names, such as 'professional breeding kennels,' 'high-volume breeders,' and 'large-scale breeders.' In some countries (e.g., the UK and Australia) these breeding establishments are referred to as 'puppy farms.' In the USA, the mass production aspect of these operations at some point gave rise to the term 'puppy mill,' which has come to be defined by many as 'a commercial farming operation in which purebred dogs are raised in large numbers' (Merriam-Webster, 2010). For the purposes of this report, high-volume puppy producing operations will be referred to as commercial breeding establishment (CBE).

In general, CBEs are operated like other production animal enterprises, and the dogs are viewed and treated as livestock (Hinds, 1993). Conditions in CBEs vary from modern, clean, and well kept to squalid, noxious, and grave and potentially detrimental to animal health and welfare (Hinds, 1993; Smalley, 2009; USDA, 2004). Common to virtually all CBEs are the following: large numbers of dogs; maximally efficient use of space by housing dogs in or near the minimum space permitted by law; housing breeding dogs for their entire reproductive lives—in most cases, years—in their cages or runs; dogs rarely if ever permitted out of their primary enclosures for exercise or play; absence of toys or other forms of enrichment; minimal to no positive human interaction or companionship; and minimal to no health care (Bradley, 2010; Fischer, 2010; Shaughness and Slawewski, 2010).

Numerous anecdotal reports suggest that dogs formerly maintained as breeding dogs in CBEs display behavioural and psychological abnormalities when compared with the general pet dog population (Bradley, 2010; Lockwood, 1995). If true, a number of factors may contribute to the development of such abnormalities, the prime candidates being severe and/or chronic stress (e.g., restrictive confinement, under- or overstimulation, social conflict, social deprivation, physical factors), inadequate socialization, genetics, and maternal adversity. The goal of the present study was to determine if the anecdotal evidence of behavioural and psychological abnormalities in dogs from CBEs could be confirmed by comparing owner-derived behavioural assessments of former CBE breeding dogs with those of typical pet dogs. Identification of any differences that adversely affect the dogs' welfare would indicate the need for, and guide the development of, preventive, corrective, and therapeutic measures.

2. Materials and methods

2.1. Data collection

Behavioural evaluations of the dogs were obtained from current owners/fosterers using the Canine Behavioural Assessment and Research Questionnaire (C-BARQ; <http://www.cbarq.org>) (Hsu and Serpell, 2003). The C-BARQ is designed to provide quantitative assessments of a wide array of behavioural characteristics of dogs, and has been widely used as a research tool for comparing behaviour in different dog populations (Duffy et al., 2008; Otto et al., 2004; Serpell and Hsu, 2005; Van den Berg et al., 2010). The questionnaire consists of 101 items which ask respondents to indicate using a series of 5-point

ordinal rating scales their dogs' typical responses to a variety of everyday situations during the recent past. The scales rate either the intensity (aggression, fear and excitability subscales) or frequency (all remaining subscales and miscellaneous items) of the behaviours, with a score of 0 indicating the absence of the behaviour and a score of 4 indicating the most intense or frequent form of the behaviour. The C-BARQ currently comprises 14 behavioural factors or subscales (calculated as the mean of the questions pertaining to each subscale), and a further 22 miscellaneous stand-alone items. Higher scores are generally less favorable for all items and subscales with the exception of trainability, for which higher scores are more desirable. In addition, the C-BARQ asks dog owners if their dog is "currently experiencing any significant health problems" (yes/no) and if they are "currently experiencing any problems with this dog's behaviour or temperament", to which they can select from among the following: no problems, only minor problems, moderate problems, serious problems. Owners were also asked to indicate the dog's current age at the time the survey was completed, the dog's age when it was acquired, and whether or not there are any other dogs living in the same household. The C-BARQ automatically records the time and date when the survey is submitted and this information, together with the aforementioned data, allowed calculation of the duration of time that the dog had been living in the home at the time of survey completion. Four sections in the C-BARQ include 'open field comments' that permit the participant to elaborate on their dog's behaviour relative to the behavioural category of the question (e.g., situations where the dog is sometimes aggressive, is fearful or anxious, becomes over-excited, and other stereotyped or repetitive behaviours).

2.2. CBE ex-breeding dog sample

Dogs were recruited for the study in one of four ways: (1) direct solicitation of adopters and fosterers of dogs previously confiscated from CBEs by an animal protection organization¹ and subsequently offered for adoption; (2) solicitation via a notice placed in the same organization's magazine; (3) all national and local animal welfare organizations listed in the Best Friends Animal Society databank as involved with 'puppy mill rescue' were contacted and asked to distribute the solicitation notice to the people with whom they had placed former breeding dogs (foster care or full adoption); and (4) a solicitation notice posted on a dog website (dogforums.com). Further distribution via word of mouth was not discouraged. No geographical restrictions were imposed. The solicitation notice for the study contained both an email address and telephone number. Individuals responding via email were provided with a link to the online questionnaire; telephone respondents were also provided with the link or, if they lacked internet access, were mailed a hardcopy of the questionnaire together with a postage-paid return envelope. The owners were made aware of the purpose of the study in the form of a single

¹ Best Friends Animal Society.

sentence included in the solicitation notices. The magazine and website notice stated that we were looking for dogs for a study of “psychological effects of living in a commercial breeding facility (“puppy mill”); the email notice sent via rescue groups announced, “a large scale study on dogs that were once used as breeding dogs in commercial breeding facilities (“puppy mills”),” with the stated purpose: “we are trying to fully understand the psychological changes that occur in the dogs that have experienced this kind of life.”

The dogs included in the study were those that had been used, or confined with the intention to be used, as breeding dogs in CBEs. The stipulation that the dog had been used for breeding purposes in a CBE/puppy mill was for the purpose of distinguishing adult dogs from puppies that were transported out for sale before 12 weeks of age. In reality, it is not possible in every case to confirm that a dog recovered from a CBE had been used for breeding. The study, however, was not intended to evaluate the effects of breeding *per se*, but rather the confinement in a CBE. The criteria used for inclusion in the study were based on the fact that, except for rare exceptions, dogs are not kept in these facilities if they are unable to successfully reproduce. Therefore, if the dog is confined in a CBE and over 1 year of age, it is a near certainty it is being used, or is intended for use, as a breeding dog. Any dog less than 8 months of age at the time of removal from the CBE was excluded from the study, and any dog over 1 year was included. Dogs between 8 and 12 months of age were included only if confirmed to be a breeding dog (or intended breeding dog) by a CBE operator. To avoid reliance on memory and hence recall bias, only dogs currently living and in that person’s care were included in the study.

To assure that each dog in the study had no known history of psychological trauma outside of their CBE experience, one question was added to the survey asking the owner to select from a list of traumatic events and/or write in any known sources of trauma their dog had experienced. Only those dogs whose owners selected the answer “was rescued from a puppy mill where he/she was being used as a breeding dog” were included in the study.

In the solicitation of participants the term ‘puppy mill’ was used for two reasons. First, while the term ‘puppy mill’ is considered by some to be derogatory and judgmental, the definitions of puppy mill and CBE may be considered synonymous. For example, Merriam-Webster (2010) defines ‘puppy mill’ as “a commercial farming operation in which purebred dogs are raised in large numbers”; this also accurately describes a canine commercial breeding establishment. Based on personal communication with the groups involved in the recovery and rescue of these dogs it is clear that the adopters and fosterers were familiar with the term ‘puppy mill’ and unfamiliar with the term ‘commercial breeding establishment.’ Second, the groups involved with rehoming these dogs have ‘puppy mill’ in their name and/or use the term to describe large commercial breeding establishments when conducting any activities or communications related to the dogs they assist.

2.3. Pet dog sample

For the purposes of comparison, a convenience sample of C-BARQ assessments of pet dogs was used. Beginning in April 2006, free access to the online version of the C-BARQ became available to pet owners. The survey was advertised via an article in the newsmagazine of the Veterinary Hospital of the University of Pennsylvania (Kruger, 2006) and by notices sent to Philadelphia-area veterinary clinics and the top 20 US breed clubs based on AKC registrations. Availability of the survey then spread via word of mouth. Breed designations are based entirely upon owner assertions. From a dataset containing 13,620 pet dogs, a subset of dogs was randomly chosen to serve as matched controls for the CBE breeding dogs. Cases were matched on the basis of age (± 6 months), sex, breed and (when possible) neuter status.

For comparison of former CBE breeding dogs with a control set of pet dogs, the analysis was limited to dogs that had been in the home for at least 3 months in order to allow sufficient time for owners to become familiar with their dogs’ typical behavioural responses. An additional 36 CBE breeding dogs were removed from analysis because their neuter status was not reported by their owners. This left us with 715 dogs in the age-verified CBE ex-breeding dog dataset for which we attempted to find a matching control case with respect to approximate age (± 6 months), sex, breed and (when possible) neuter status within the pet owner dataset. We were able to find age-, sex-, and breed-matched controls for 332 of the CBE ex-breeding dogs, yielding a total sample size of 664 dogs (332 CBE ex-breeding dogs and 332 matched controls). As reported by their owners, the control cases had been acquired from a variety of sources (‘bred by owner’: 9 (2.7%), ‘breeder’: 181 (54.5%), ‘pet store’: 22 (6.6%), ‘friend or relative’: 33 (9.9%), ‘stray’: 8 (2.4%), ‘shelter’: 62 (18.7%), and ‘other’: 17 (5.1%).

2.4. Statistical analyses

All statistical analyses were performed using SPSS version 17 software. Chi-square tests were used to compare categorical variables between the two samples (CBE ex-breeding dogs and pet dogs). A Kruskal–Wallis test was used to compare the duration of ownership between the two samples. Ordinal Generalized Linear Models (GLM) were fitted to assess the effect of the dog’s background (CBE ex-breeding dogs versus matched controls) on each C-BARQ item/subscale, with the presence of other dogs in the home (other dogs; yes/no), the length of time in the home (duration of ownership in months), and neuter status included as potential confounding effects. Corrections for multiple tests were performed using a Sequential Bonferroni procedure (Holm, 1979) in which $P_i \leq \alpha / (1 + k - i)$ where $\alpha = 0.05$, $k = 36$ and $P_i = P_1, P_2, P_3, \dots, P_{36}$.

3. Results

3.1. CBE ex-breeding dog data

A total of 1420 completed surveys were received, of which 251 were eliminated because: (1) the dog was not a

former CBE breeding dog, (2) the dog's CBE breeding history could not be ascertained from the owner, and (3) the questionnaires were incomplete or contained duplicate entries. This left a final sample size of 1169 for the descriptive analysis of CBE dogs. Due to some initial errors in the owners' reporting of the age of the dogs when evaluated and when acquired (e.g., some cases where the age at which the dog was evaluated was younger than when it was reportedly acquired), owners of all former CBE breeding dogs were contacted in order to verify the age of the dog and the approximate date on which it was obtained. Of these, 851 responded with the information necessary to perform analyses involving the dogs' ages and length of time living in the home.

Among the CBE ex-breeding dogs, 76 different breeds were represented. The largest represented breed was the Bichon Frise (31.5%); Papillon, Shih Tzu, and Golden Retriever each comprised just under 5% of the dogs (4.96%, 4.96%, 4.88%, respectively). Other breeds comprised 4% or less of the population. The most likely explanation for the high proportion of Bichon Frises in our study is that the director of a very large Bichon breed rescue organization (Small Paws Rescue, Tulsa, Oklahoma) was extremely diligent in obtaining the participation of the adopters of their former CBE dogs. The sex ratio was 70.3% females and 29.7% males, consistent with the greater proportion of breeding females than males in CBEs. Most of the dogs were living in multi-dog households (91.4%).

Health problems affected approximately one-quarter (26.8%) of CBE ex-breeding dogs, while behavioural concerns were reported in over 80% of the dogs, with 47.9% reporting only minor behavioural problems, and 33.2% reporting moderate to serious problems. Based on the subset of former CBE breeding dogs for whom the age when acquired and evaluated could be verified ($N=851$), dogs were acquired at the age of 5 years on average (± 0.09 SE; minimum and maximum age acquired: 0.83 years and 15 years, respectively) and had been living in their adoptive homes for an average of 24 months (± 10.08 SE; minimum and maximum time in the home: <1 month and 202 months, respectively) when the C-BARQ was completed. On average, dogs were 7 years old (± 0.12 SE) at the time of data collection (minimum and maximum ages: 1 year and 25 years old, respectively). It should be borne in mind, however, that estimates of CBE dogs' ages are, in many cases, a matter of educated guesswork based on standard aging criteria, such as dental disease and body condition (Hinds, 1993; USDA, 2004).

3.2. Comparison of former CBE breeding dogs with 'typical' pet dogs

Fifty different breeds were represented in the data; 17.5% of the samples were Bichon Frise and 12% were Golden Retrievers. Chihuahuas, Shih Tzus, and Papillons comprised 6.9%, 5.7%, and 4.8% of the data, respectively. The remaining breeds each comprised $\leq 4\%$ of the data, all of which were included in the analysis. The combined sample consisted of 65.7% females and 34.3% males.

Health and behavioural concerns were reported at significantly higher rates among owners of former CBE

Table 1
Frequency of reports of health problems and behavioural concerns by owners of former CBE breeders and matched pet owners.

	CBE ex-breeding dogs	Matched controls
<i>Health problems</i>		
Yes	78 (24) ^a	55 (17)
No	254 (77)	277 (83)
<i>Behavioural concerns</i>		
No problems	56 (17)	146 (44)
Only minor problems	166 (50)	119 (36)
Moderate problems	90 (27)	53 (16)
Serious problems	20 (6)	14 (4)
Total	332	332

^a Numbers in parentheses indicate percentages within each dataset.

breeding dogs than for matched controls, with 23.5% of CBE ex-breeding dog owners reporting health problems compared to 16.6% of matched pet owners ($\chi^2=4.974$, $df=1$, $P=0.026$), and 83.1% reporting behavioural concerns compared to 56.0% of pet owners ($\chi^2=57.63$, $df=1$, $P<0.0001$) (see Table 1). A significantly greater proportion of former CBE ex-breeding dogs lived in multi-dog households compared to the matched controls (88.6% compared to 67.8%, respectively; Chi-square test, $\chi^2=42.0$, $df=1$, $P<0.0001$). The duration of time for which the dogs had been living in the home prior to evaluation was significantly lower among former CBE ex-breeding dogs than the matched controls (Kruskal–Wallis test: $\chi^2=240.6$, $df=1$, $P<0.0001$; mean number of months = 20.6 ± 1.07 SE for former CBE ex-breeding dogs versus 57.5 ± 1.92 SE for matched controls).

We compared the C-BARQ scores of former CBE breeding dogs to matched controls using separate multinomial ordinal GLMs (with cumulative logit link function) with the C-BARQ item/subscale as the response variable for each model. For the response variables, the 22 stand-alone items were used in their original raw format (i.e., the ordinal scale of 0 through 4). Due to their non-normal and often highly skewed, semi-discrete distributions, the 14 subscales were converted into ordinal variables using quartiles as the cut-off values (see Table 2). The presence of other dogs in the

Table 2
Quartiles used to create discrete ordinal categories for each of the 14 subscales. Scores at or below each cutoff value were recoded as indicated in the column header. Numbers in parentheses indicate the number of questions that comprise each subscale.

C-BARQ subscale	1	2	3	4
Stranger-directed aggression (10)	0	0.2	0.8	>0.8
Owner-directed aggression (8)	0	0.125	>0.125	n/a ^a
Dog-directed aggression (4)	0	0.25	1.0	>1.0
Dog rivalry (4)	0	0.25	0.75	>0.75
Trainability (8)	1.75	2.25	2.75	>2.75
Chasing (4)	0.25	1.5	2.5	>2.5
Stranger-directed fear (4)	0	1.0	2.75	>2.75
Dog-directed fear (4)	0.25	0.75	1.667	>1.667
Nonsocial fear (6)	0.5	1.083	2.0	>2.0
Separation-related problems (8)	0.125	0.5	1.0	>1.0
Touch sensitivity (4)	0.25	1.0	1.67	>1.67
Excitability (6)	1.5	2.0	2.67	>2.67
Attachment/attention-seeking (6)	1.5	2.0	2.67	>2.67
Energy (2)	1.0	1.5	2.5	>2.5

^a The first and second quartiles had the value of 0, therefore only 3 categories were formed.

Table 3
Results of the ordinal Generalized Linear Models. *P* values represent the main effect of being a former CBE breeding dog.

Response variable	<i>P</i>	Odds ratio	<i>B</i>	SE	95% CI	Confounders ^b
Escapes^a	0.002	0.56	-0.571	0.183	(-0.929, -0.212)	
Rolls in feces	0.009	0.62	-0.473	0.183	(-0.831, -0.116)	
Coprophagia	0.013	1.58	0.455	0.183	(0.098, 0.813)	1
Chews	0.701					3
Mounts	0.015	0.53	-0.629	0.258	(-1.135, -0.124)	
Begs	0.003	0.60	-0.512	0.173	(-0.851, -0.173)	1
Steals food	0.011	0.63	-0.466	0.183	(-0.824, -0.108)	2
Nervous on stairs	<0.0001	5.98	1.789	0.222	(1.353, 2.225)	
Pulls on leash	0.0002	0.51	-0.679	0.183	(-1.037, -0.320)	1, 3
Urine marking	0.001	2.06	0.724	0.222	(0.290, 1.159)	1, 2
Emotional urination	0.959					
Urination when left alone	<0.0001	2.81	1.032	0.197	(0.647, 1.416)	2
Defecation when left alone	0.0003	2.07	0.726	0.202	(0.331, 1.121)	2
Hyperactive	0.012	0.62	-0.482	0.191	(-0.856, -0.108)	3
Stares Intently at nothing visible	0.003	1.87	0.626	0.210	(0.215, 1.037)	1
Snaps at flies	0.257					
Tail chasing	0.011	0.50	-0.688	0.269	(-1.216, -0.160)	1, 3
Shadow chasing	0.001	0.40	-0.927	0.282	(-1.481, -0.373)	1
Barks persistently	0.004	0.61	-0.501	0.174	(-0.842, -0.159)	
Self grooming	0.007	1.65	0.499	0.186	(0.135, 0.864)	1, 3
Allo grooming	0.072					1
Other stereotyped behaviour	0.005	1.91	0.648	0.229	(0.199, 1.098)	
Stranger-directed aggression	<0.0001	0.40	-0.942	0.183	(-1.299, -0.585)	1
Owner-directed aggression	0.004	0.55	-0.606	0.211	(-1.020, -0.191)	1
Dog-directed aggression	<0.0001	0.30	-1.202	0.188	(-1.569, -0.834)	
Dog rivalry	<0.0001	0.42	-0.864	0.191	(-1.237, -0.490)	
Separation-related problems	0.093					1
Trainability	<0.0001	0.25	-1.370	0.186	(-1.734, -1.006)	
Chasing small animals	<0.0001	0.20	-1.623	0.195	(-2.004, -1.242)	
Stranger-directed fear	<0.0001	8.12	2.094	0.195	(1.712, 2.476)	
Dog-directed fear	0.002	1.78	0.577	0.183	(0.220, 0.835)	1
Nonsocial fear	<0.0001	6.62	1.89	0.193	(1.511, 2.269)	
Touch sensitivity	<0.0001	3.19	1.161	0.182	(0.803, 1.518)	
Excitability	<0.0001	0.47	-0.761	0.179	(-1.112, -0.409)	
Attachment/attention-seeking	0.846					3
Energy	<0.0001	0.29	-1.253	0.184	(-1.614, -0.893)	3

^a Items in boldface are significantly different after sequential Bonferroni correction.

^b Confounders with main effects: 1 = other dogs in household, 2 = neuter status, 3 = duration of ownership. Boldface indicates significance with sequential Bonferroni correction.

home (other dogs; yes/no), the length of time in the home (duration of ownership in months), and neuter status were also included as potential confounding effects. The latter was included because it was not possible to match every case with respect to neuter status. The CBE ex-breeding dog dataset contained four intact dogs (two male, two female) while the matched control dataset contained 20 intact dogs (15 female, 5 male). The remaining dogs were all neutered at the time of evaluation and both intact and neutered dogs were included in the analyses. Due to the severe imbalance or skewed nature of the confounding variables, interaction terms could not be included without encountering quasi-complete separation of the data; therefore, only main effects were included in the models.

Significant differences were found between CBE ex-breeding dogs and matched controls for 20 out of 36 behavioural variables measured by the C-BARQ (see Table 3). In general, CBE ex-breeding dogs exhibited more fear/nervousness, compulsive behaviours (defined as behaviours that are usually brought on by conflict, but subsequently displayed out of context and are often repetitive, exaggerated or sustained' (Hewson and Luescher, 1996), e.g., staring at nothing visible), house soiling when left alone, and sensitivity to touch compared to matched

controls, and less aggression, excitability, energy, chasing small animals, and escaping/roaming. Most notably, CBE ex-breeding dogs showed markedly higher levels of fear. Compared to matched controls, the odds of scoring in the upper quartiles for stranger-directed fear were more than eight times higher in CBE ex-breeding dogs while holding the intervening variables constant. Likewise, the odds of scoring in the upper quartiles for nonsocial fear or receiving a higher scale score for 'nervous on stairs' were nearly six times greater for CBE ex-breeding dogs compared to matched controls. In addition, scoring in the upper quartiles for trainability (which would indicate a dog that is more easily trained) was 75% less likely for CBE ex-breeding dogs compared to matched controls when the intervening variables were held constant.

CBE ex-breeding dogs showed significantly lower levels of aggression compared to matched controls. They were 60% less likely to score in the upper quartiles for aggression directed toward strangers than matched controls when intervening variables were held constant. CBE ex-breeding dogs also scored lower for aggression directed toward other dogs (58% and 70% less likely to score in the upper quartiles for aggression toward familiar and unfamiliar dogs, respectively). Likewise, CBE ex-breeding dogs were 71%

and 53% less likely than matched controls to score in the upper quartiles for energy level and excitability, respectively. CBE ex-breeding dogs were 80% less likely to score in the upper quartiles for chasing small animals compared to matched controls when intervening variables were held constant.

The presence or absence of other dogs in the household had a significant main effect on a number of behaviours (Table 3), with dogs living in multi-dog households scoring more favorably than dogs in single-dog homes for all but coprophagia and urine marking. Neuter status had only marginal effects (Table 3), with intact dogs scoring less favorably, that did not reach statistical significance when corrections for multiple comparisons were made. The duration of time in the household also had a number of effects on behaviour, with increased time in the home associated with improved behaviour for all except self-grooming (Table 3).

4. Discussion

The psychological state that most obviously distinguishes former CBE breeding dogs from typical pet dogs is fear. As determined by their numerical scores on most of the C-BARQ fear subscales (fear of strangers, fear of stairs, nonsocial fears, and touch sensitivity), many of these dogs appear to experience regular and often persistent fear or anxiety, even after years in their adoptive households. The psychological composition of elevated fears toward unfamiliar people and dogs while demonstrating decreased aggression toward the same would tend to indicate chronic up-regulation of the hypothalamic–pituitary axis (HPA) “fight or flight” mechanism with a bias toward flight. In addition, CBE ex-breeding dogs exhibited significantly higher frequencies of house-soiling (urination and defecation when left alone, and urine marking) and compulsive behaviours, and significantly reduced scores for aggression, trainability, chasing small animals, excitability, and energy.

The abnormal behaviours (as compared to the control population) observed in the former CBE breeding dogs in this study have multiple potential causes. However, the two explanations most consistent with the findings are stress-induced psychopathology and inadequate early socialization and/or lack of exposure to environmental stimuli normally found in the lives of typical pet dogs.

4.1. Stress-induced psychopathology

Although no studies on sources of stress in CBEs or their potential effects on the well-being of the dogs have been published, these factors have been investigated in dogs living in confinement in kennels (Beerda et al., 1999a,b; Hiby et al., 2006; Lefebvre et al., 2009; Rooney et al., 2007; Stephen and Ledger, 2005; Taylor and Mills, 2007), animal shelters (Tuber et al., 1999; Wells et al., 2002), and laboratories (Campbell et al., 1988; Hubrecht, 1993; Hughes et al., 1989). Similar stressors have been documented in the CBE environment (USDA, 2004), and it is therefore reasonable to presume that the findings for dogs confined in kennels, shelters, and laboratories are applicable to the dogs in the present study, despite some differences in

background, housing and husbandry. Specific factors that have been determined to be associated with stress in dogs living in confined environments include: spatial restriction (Beerda et al., 1999a,b; Wells et al., 2002); extreme temperatures (Morgan and Tromborg, 2007; Smalley, 2009; USDA, 2004); aversive interactions with kennel staff (Morgan and Tromborg, 2007; Scott and Fuller, 1965); lack of ‘control’ or the capacity to avoid or regulate exposure to aversive stimuli (Stephen and Ledger, 2005; Taylor and Mills, 2007; Tuber et al., 1999; Wells et al., 2002), and limited access to positive human and conspecific social interactions (Beerda et al., 1999a; Hubrecht, 1993; Hubrecht et al., 1992; Hughes et al., 1989).

The fact that dogs used for breeding purposes in CBEs typically live for years in the facility raises the issue of chronicity of stressor exposure; specifically, whether the kennel and shelter-related stressors just discussed are, when experienced chronically, sufficient for causing psychopathological changes in dogs. Recent studies in humans have demonstrated that chronic adversity in people has the potential to create profound emotional scars that may affect the individual for the remainder of his or her life (Niederland, 1964; van der Kolk et al., 2005). Chronic stress in dogs in kennel and shelter environments has been the subject of a few studies. Beerda et al. (2000) reported that dogs unable to cope successfully with inadequate housing conditions may become chronically stressed, as indicated by physiological indices and behaviour. The dogs may develop abnormal behaviours such as hyperactivity, timidity, aggression, and stereotypic locomotory behaviours (circling, pacing, and wall-bouncing) (Hubrecht, 1992; Hubrecht et al., 1992).

Physical health problems were reported at significantly higher rates among owners of former CBE breeding dogs than for matched controls. This may simply reflect standard health care while in the CBE; however, adverse effects of stress on physical health are well-documented (Riley, 1981; Weiss, 1972) and numerous studies in humans and other animals have determined that exposure to chronic stress or traumatic events is associated with poor physical health and increased susceptibility to disease (Broom and Kirkden, 2004; Krause et al., 2004). Such effects may act over lengthy periods: longitudinal research shows that adverse and traumatic childhood experiences may impair physical health into adulthood (Edwards et al., 2003).

4.2. Inadequate socialization

The second major potential cause of many of the signs observed in the dogs in the present study is inadequate socialization and/or insufficient exposure to environmental stimuli during the first few months of life. The sensitive period for socialization occurs during the first 4 months of life (Scott and Fuller, 1965; Serpell and Jagoe, 1995), and, with rare exceptions, CBE breeding dogs are themselves conceived, born, and raised in CBEs, and live in CBEs throughout their sensitive periods (Hughes, personal communication, 2009). Various early experimental studies have demonstrated that young dogs reared in socially and environmentally impoverished conditions during the first 4–6 months subsequently have great difficulty adapting

to novel environments. Dogs reared entirely in kennels, for example, exhibit a condition—sometimes known as ‘kennel-dog syndrome’—characterized by extreme fear and timidity when subsequently exposed to unfamiliar social interactions or environments (Clarke et al., 1951; Melzack and Thompson, 1956; Panksepp et al., 1983; Scott and Fuller, 1965; Serpell and Jagoe, 1995). Other studies have indicated that pups that are socially isolated from 3 days to 20 weeks of age are disturbed for life (Agrawal et al., 1967) and have impaired learning ability (Melzack and Scott, 1957). These effects of exposure to restricted early rearing conditions are usually extremely persistent and resistant to rehabilitation (Panksepp et al., 1983), an outcome that may be due to irreversible alterations in the structure and complexity of the developing brain (Serpell et al., 2006).

As a group, the CBE dogs in the present study exhibit a variety of abnormal behaviours consistent with the effects of poor socialization and stimulus deprivation in early life (Freedman et al., 1961; Scott and Fuller, 1965; Serpell and Jagoe, 1995). These include extreme fear responses to anyone or anything unfamiliar, compulsive or stereotypic behaviours, and reduced trainability (due to either cognitive deficits or an inability to relate properly to humans). Other unusual aspects of their behaviour, including exceptionally low levels of aggression, chasing small animals, energy and excitability (reactivity), and increased touch sensitivity, fear of stairs, and house-soiling, could also be plausibly attributed to lack of relevant environmental experience during appropriate sensitive periods in early development (Serpell and Jagoe, 1995).

4.3. Other potential causes of psychobehavioural abnormalities in former CBE dogs

In view of the fact that the prenatal life of breeding dogs occurs in CBEs, the conditions and events during this period may play a role in the psychological development of the fetus. The effects on the developing offspring of stress experienced by the pregnant mother have been the subject of a large body of research. Offspring of pregnant animals exposed to various stressors have been documented with neurohormonal dysfunction (Seckl, 2004) and dysregulation of the HPA axis (Dickerson et al., 2005); abnormal response to (Henry et al., 1994), increased sensitivity to (Mastorci et al., 2009), and impaired ability to cope with stress (Braastad, 1998); exaggerated distress responses to aversive events (Morgan and Thayer, 1997); impaired learning (Nishio et al., 2001); abnormal social behaviour (Clarke and Schneider, 1993); increased emotionality and fear-related behaviour (Lehmann et al., 2000) and fearful behaviours that increase with increasing age (Dickerson et al., 2005); increased susceptibility to pathophysiological outcomes when further adversity occurs during adulthood (Mastorci et al., 2009); and behavioural deficits and molecular changes in the offspring similar to those in schizophrenic humans (Lee et al., 2007).

Longitudinal research in humans shows that adverse and traumatic childhood experiences—or, early life adversity (ELA)—impair mental and physical health into adulthood (Edwards et al., 2003). Studies in humans have identified ELA as a major risk factor for many serious adult

mental health problems, such as unstable social relationships and anxiety and depressive mood disorders (Heim et al., 2002; Shea et al., 2005). Evidence from studies of human (Edwards et al., 2003) and nonhuman (Ladd et al., 2000) animals supports the thesis that ELA has extensive and enduring effects with strong correlations to the development of psychopathology later in life. Several rodent and primate models of ELA, including those that model maternal separation or loss, abuse, neglect, and social deprivation, have demonstrated that early experiences of major adversity are associated with long-term alterations in neuroendocrine responsiveness to stress, emotional and behavioural regulation, coping style, cognitive function, quality of social affiliations and relationships, and expression levels of nervous system genes shown to be associated with anxiety and mood disorders (Cohen et al., 2006; Sanchez et al., 2001).

Canine studies of the long-term effects of ELA are scarce. In their influential work on behavioural genetics in dogs, Scott and Fuller (1965) wrote that “the emotional sensitivity of the puppy during the period of socialization suggests that this period might also be a critical one for permanent psychological damage.” Subsequently, Fox and Stelzner (1966) were able to demonstrate a short period at approximately 8 weeks when puppies were hypersensitive to distressing psychological or physical stimuli, and during which a single unpleasant experience could produce long-term aversive or abnormal effects. They concluded that during this brief period of puppyhood, dogs are particularly vulnerable to psychological damage. As a result of being raised in the CBE environment, the dogs in this study were presumably exposed to the stressors inherent in this environment during the early developmental stage of their lives. Consequently, the origins of the psychological changes recognized in this study may also be traceable to stressful events of the dogs’ early life.

In summary, multiple factors may by themselves or in combination play a contributory role in the psychobehavioural abnormalities seen in the former breeding dogs from CBEs. However, the data are unable to determine specific causative relationships.

A final, and crucial, point of discussion is that anecdotal evidence as well as unpublished data on 878 of the dogs in this study show that many of the ex-CBE dogs can and will overcome much of the increased levels of fear through dedicated behavioural therapy and extreme patience on the part of the dogs’ adoptive owners. Because of the large degree of success in rehabilitation we wish to make it clear that these dogs are not to be avoided as pets. Further, because of the fact that many of the dogs improve over time and were likely to have been in an improved state when they were entered in the study, the differences revealed in this study are possibly an underestimate of the full extent of the effects of CBE life.

5. Limitations

It is important to acknowledge the potential limitations of the current findings. Both CBE ex-breeding dogs and matched control samples were self-selected and may therefore be unrepresentative of the populations from

which they were drawn. Also, while every effort was made to match the pet dog and CBE samples, participants were recruited in different ways, and the samples differed from each other in other important respects (e.g., reproductive history, etc.). These differences may have contributed in unknown ways to the observed differences in C-BARQ scores. We also cannot rule out the possibility that a small proportion of the dogs in the matched control sample came originally from CBEs. However, if some of the controls were formerly from CBEs, the expectation would be that this would create more overlap between the two populations, thus reducing the size of any observed differences. Therefore, if anything, the differences reported in the present study are conservative estimates of the effects of being former CBE breeding dogs. In addition, the adoptive owners of former CBE breeding dogs were aware of the purpose of the study and may therefore have been sensitized to, and more likely to report, any unusual behaviour of their dogs when compared to the pet owners.

6. Conclusions

Substantial anecdotal evidence suggests that the welfare of dogs in commercial breeding establishments (or puppy mills) is poor, but scientific evidence has heretofore been lacking. By demonstrating that dogs maintained in these environments were reported to have developed long-term fears and phobias, compulsive behaviours such as circling and pacing, possible learning deficits, and are often unable to cope fully with normal existence, this study provides the first clear quantitative evidence that dogs confined in CBEs for breeding purposes demonstrate impaired mental health and, as a result, diminished welfare.

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Conflicts of interest

The authors declare that no conflict of interest exists in which any author or authors' institution has a financial or other relationship with other people or organizations that may inappropriately influence the authors' work.

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